Repeatability, reproducibility and influence of visual stimuli on hand evaluation of fabrics during long time period

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A lot of work and a big effort have been devoted to the area of understanding of sensory analysis of subjective hand evaluation and its objective prediction. So that the proposed models of objective evaluation can have validity for a longer time, the repeatability and reproducibility of total hand are necessary. In this paper the reproducibility, repeatability and influence of visual stimuli on the hand evaluation are verified by means of linear regression and using Spearman's rank correlation coefficient. Eleven degrees ordinal scale was applied and a sample rating median was analyzed. Three groups of respondents evaluated total hand during approximately one decade. The results indicate the possibility to reach repeatability and reproducibility of hand evaluation during long time period. Influence of visual stimuli was not proved clearly.
Key words: *total hand, hand evaluation, repeatability, reproducibility, rating median, visual stimuli*

1. Introduction

The hand of textiles belongs to the basic tactile properties. Its importance is apparent when a consumer considers a purchase of a garment or textile product, as the hand is what he or she mostly evaluates beside the appearance. So, the hand belongs to the first characteristics coming into contact with a consumer. This evaluation is called subjective hand evaluation. However, the final definition of hand is not still unified. It is understood as a feeling evoked by a contact between textile and skin, and in the case of hand evaluation mainly between textile and fingers and palm. The definition formulated by the Textile Institute [1] has the form "The quality of a fabric or yarn assessed by reaction obtained from the sense of touch". Another definition can be found in the works of Matsuo at al [2], AATCC [3] and Bishop [4]. A big effort has been devoted to the understanding of hand perception for the past 40 - 50 years. Currently, the effort has focused on a rapidly developing e-shopping when the purchase is made without contact and the consumer needs to have some idea about the hand. Therefore some techniques based on measurable properties having a relation to the subjective evaluation are developed. Such evaluation is called objective hand evaluation and it is used for the prediction of the subjective one. The connection between the subjective hand evaluation and the objective hand evaluation is often given by regression models.

It was proved [5] that experts independently of each other classify the primary components of the hand at first, and only then do they make a final verdict about the hand. The hand concept is directly or indirectly connected with such attributes as cotton, rich, velvety, silky, smooth, soft, full, warm, tough, hard, etc., which can evoke similar associations of subjects. Group around Kim [6] gathered 144 such expressions that specify the concept of the hand closer. A similar number of expressions – 136 were also found in the study by Philippe et al. [7]. These formulations express complex sensual perceptions

and form primary components of the hand. For the better expression of the sensory understanding of the hand primary components was suggested applying so called "polar pairs" (for example rough - smooth) [8]. This is conditioned by a simply interpretable definition of the qualities characterizing the polar pair, which would correspond to the elementary process of sensory perception.

Just as each person perceives the surrounding world differently, so they will feel the hand of textile. It depends on their current psychic and physical condition, surrounding conditions, whether the evaluator involved is an expert or a standard consumer. Such an evaluation is always subjective, therefore it is appropriate to have the textile evaluated by more evaluators, and to process the results statistically.

The hand of textiles is understood as complex psychophysical property. It means that the subjective hand percept is a weighted mean of a single primary hand stimulus and personal knowledge of the evaluator. In addition to the textile construction, treatment (finishing), appearance, etc., the decision about whether the textile will be felt as pleasant to the touch will also depend on the evaluator´s current psychic frame of mind, his/her experience, sensitivity of the contact place (most often fingers and palms by the evaluation), so based on their subjective feelings the textile will be evaluated differently by each evaluator.

Subjective evaluation of the hand is known to be burdened with serious inaccuracy unless the conditions leading to a certain level of reproducibility (objectivity) are provided. The evaluation stability (repeatability and reproducibility) is important for objective prediction – gives prediction equation validity for a longer period. Winakor et al. [9] discussed 4 problems connected with the preparation and course of any subjective hand evaluation having basic relation to creation of objective prediction of hand:

a) expert vs. native judges,
b) problems of scales,
c) the semantic differential,
d) individual differences.

Bishop [4] presented and discussed six elements for the subjective hand evaluation:

1) the judges,
2) the criteria of judgement,
3) the assessment conditions,
4) the assessment technique,
5) the method of ranking or scaling the assessment,
6) the analysis of results.

In addition to the points having some relation to the preparation of the experiment (points 1-5) he also mentions the analysis of results (point 6).

One of the questions solved during the experiment preparation is "To carry out subjective evaluation with or without visual stimuli? ". The answer is not quite unambiguous. It was found out that fabric construction, surface detail and fabric lustre play an important role in evaluation and leads to its changes [10]. On the other hand, in the study [11] was concluded that visual effect, colour, had no significant influence on the tactile hand sensory properties of fabrics made from cotton. The weak influence of weave on the roughness was found in [12].

Therefore, investigaton of general changes in hand evaluation of fabrics and verifying reproducibility, repeatability and influence of visual stimuli on the hand evaluation during long time period are the aims of this paper.

2. Material and methods

In order to ensure reproducibility and repeatability, the arrangement of the experiment had to be clarified for the beginning. Answers on the questions concerning the choice of respondents, the choice of the grade scale and the assessment technique were established.

1.1. Material

For the purpose of the research 47 woollen men's suiting fabrics were collected from Czech standard production. The samples 0,7 x 0,7 m were prepared and sensorial judged. The information on the range of the basic parameters of the tested fabrics is summarized in Tab.1.

1.2. Choice of respondents

Three groups of respondents educated in the textile area, however, with short experience with subjective hand evaluation participated in the experiment. The first group (G1) consisted of the panel of 30 respondents from the age of 20 to 26 years, the second one (G2) of the panel of 40 respondents from the age of 20 to 28 years and the third group (G3) was consisted of the panel of 21 respondents from the age of 20 to 27 years.

1.3. Choice of scale

All groups had eleven degree ordinal scale (Tab.2) to disposal. The scale was adopted in accordance with the work [5] where the single categories are characterized.

1.4. Data treatment

Subjective hand evaluation belongs to sensory methods when precepts of sense organs are analysed without the use of technical gauges. For a more simple interpretation of the hand evaluation an ordinal scale is selected and used for the textile evaluation by the judges.

By the subjective hand evaluation M fabrics (m=1,2,3,….M) is evaluated by the touch and categorized by N respondents (n=1,2,3,….N) on the basis of their tactile sensation. They have an ordinal scale at their disposal, consisting of K categories (k=1, 2,…. K) classified from the worse category C_1 to the best one C_K (Table 2).

Application of numeric values at scale methods can result in their handling in the same way as with common data, and therefore arithmetic means and variances are calculated.

It is necessary to take into account the fact that linear scales are not concerned and the differences between neighbouring categories must not be understood constant, so especially the arithmetic mean can provide a distorted view of the results in the cases when the data is not classified symmetrically. It is also difficult to detect if the same quantification evaluation (classification in the same category) is really identical. Application of the ordinal scale, and subsequently also an ordinal variable means that classical estimators of location and variance cannot be used directly. Therefore, it is more suitable to use a median of the ordinal scale x_R [19] as a location estimator from the results of the textile hand evaluation (1), which is defined:

$$x_R = Me + 0.5 - \frac{F_{Me} - 0.5}{f_{Me}} \quad (1)$$

where *Me* is a median category which is defined by inequalities (2):

$$F_{Me-1} < 0.5, \qquad F_{Me} \geq 0.5 \quad (2)$$

F_{Me} is cumulative relative frequency of median category and f_{Me} is relative frequency of median category. Median of the ordinal scale x_{Rm} is then obtained (3) for each fabric (m=1,2,3,….M).

$$x_{R\,m} = Me_m + 0.5 - \frac{F_{Me\,m} - 0.5}{f_{Me\,m}} \quad (3)$$

3. Experimental part

3.1. Reproducibility, repeatability and influence of visual stimuli

Reproducibility and repeatability play an important role in the area of the prediction of the objective hand evaluation. The possibility of the stability of the subjective hand evaluation guarantees long-term credibility of the results acquired from the prediction equation. Reproducibility also enables the conclusions ensured from the acquired results to be extended on the population which the evaluators come from. Reproducibility of hand evaluation was verified by twice evaluation of the same set of fabrics by the different group of evaluators. Repeatability reveals wether the evaluators are able to evaluate the hand of fabrics by the same way. This one was verified by twice evaluation of the same set of fabrics by the same group of evaluators.

As the conclusions about influence of visual stimuli are ambiguous, its effect on evaluation was also investigated. The panel of respondents evaluated the same set of fabrics with and without visual stimuli. During the evaluation of hand without visual stimuli no visual contact with fabrics was allowed. The evaluator had in front of him a barrier so high and wide so that he could not see the fabrics submitted for evaluation. There were only two holes for hands in the barrier. The size of the holes provided a convenient handling with the samples but they were so small that the fabric could not be observed. For evaluation with the visual stimuli that barrier was removed.

Verifying of reproducibility and repeatability of hand evaluation and the influence of visual stimuli was carried out by means three panels of respondents. Time period among the first and the last evaluation is more than 8 years where time period among evaluations for G1 and G2 was about three years and among G2 and G3 about five years.

The group G1: the set of assessments of the total hand value (THV) was composed of evaluation without and with visual stimuli. The evaluation with visual stimuli was carried out one week after the evaluation without visual stimuli. The time period between the first and the second evaluation was at least 4 months.

The group G2: they carried out only evaluation with visual stimuli. Also in this case the second evaluation was carried out approximately 4 months after the first one.

The group G3: they evaluated the fabrics once without visual stimuli and once with visual stimuli. The time period between the evaluations was also approximately 1 week. The realized evaluations are evident from Tab.3.

Tab.1 Range of basic parameters

Fabric unit weight	g/m^2	140 - 380
Sett - warp - weft	threads/10 cm	160 - 500 140 - 300
Material composition	100 % wool, 45 / 55 % wool / polyester	
Weaves	plain or plain derivates, twill or twill derivates, sateen or sateen derivates	

3.2. Choice of the samples

All experiments were conducted under standard conditions. Before the start of the test the samples were conditioned for 24 hours. A preliminary assessment of all 47 textiles was carried out by the panel of 4 experts widely experienced in subjective hand evaluation. The experts discussed the hand of the single fabrics and sorted them into rank from the fabric with the worst hand to the fabric with the best one. The same rank was assigned to the fabrics with the same evaluation of hand. This preliminary assessment was the basis for the selection of 28 fabrics that were used to verify the repeatability and reprodu-

Tab.2 Applied ordinal scale

11-degree ordinal scale		
1	very poor	
2	bad	worse
3		medium
4		better
5	average	worse
6		medium
7		better
8	good	worse
9		medium
10		better
11	excellent	

cibility of subjective hand evaluation. 28 fabrics were chosen in the following way: 5 fabrics evaluated as with the best total hand (the last 5 fabrics in order), 5 fabrics evaluated as with the worst total hand (the first 5 fabrics in order), 6 fabrics evaluated as the nearest to the „average" total hand, 6 fabrics were randomly chosen from the textiles lying between the group with the worst total hand and the group with the average hand and 6 fabrics lying between the group with the average total hand and the group with the best total hand. 28 fabrics were evaluated by groups G1 and G2.

The group G3 had only 10 fabrics at their disposal, which had been chosen from 28 fabrics judged by the first two groups. As from the experiments performed by the first two groups 6 values of medians of ordinal scale x_R has been obtained (Table 3), the mean x_{RA} was calculated for the each fabric and sorted according to size and rank statistics $x_{R(m)}$ were obtained. The fabrics with rank (m) on positions (m)=1, 5, 8, 11, 13, 16, 18, 21, 24, 28 were chosen.

3.3. Course of handling

It was determined [13, 14] that the hand evaluation is sensitive to four exposures of fabrics - smoothness, stiffness, compactness and thermal character. This led Lundgren to the idea that there exist four sensory centres with the relation to the hand evaluation [15] – a centre of surface smoothness and roughness, centre of stiffness and flexibility, centre of bulk properties and centre of perception of cold and warm. The course of the "handling" itself was carried out in respects with finding of results [4, 5, 7,13-18]. To ensure the same course of the "handling" this one was strictly controlled to ensure the maximally similar approach and condition for the final fabric hand evaluation.

In advance, at least one day before the experiment all evaluators were informed in accordance with sensory analysis about the schedule of the testing, the course of the testing, approximate time consumption, how many textiles will be evaluated.

Just before the experiment they were acquainted with the purpose of the use of the textiles tested, the evaluation scale at their disposal, the form and the way of its completion, the way of the hand feeling.

At the beginning of the testing the judges washed their hands with soap and dried them. The following step consisted in training in handling of evaluation on three fabrics that had not been included in the experiment, and a follow-up discussion. The fabric with the best and the worst hand resulting from the evaluation of the experts set and introduced the range of feeling. Then 28 fabrics (or 10 respectively) were handled and evaluated without visual stimuli. Evaluation with visual stimuli was replicated approximately one week later.

After each evaluation the result of assessment was recorded by the organizer to a pre-prepared form.

4. Results and discussion

The values of basic characteristics of a sample rating median x_R – minimum, maximum and total mean of values for the single types of the evaluations of the total hand are presented in Tab.3. The total mean values for all evaluations of THV without visual stimuli are similar and fluctuate from 5.7 to 5.9. The group G3 did not evaluate the fabrics with downright bad hand. It can indicate that the view of "bad" hand can change in some time. G3 differs in its evaluation of the total hand with visual stimuli from the other two groups. The total mean of the rating median is less than at least 0.8 point. It means that the judges evaluated fabrics nearly by one category lower than the other two groups. It indicates that some influence of the visual aspect of the fabrics may have occurred. As between fabrics production and their evaluation passed more than eight years, their decision during hand evaluation may have been mainly affected by trendiness.

Spearman's rank correlation coefficient r_s and linear regression model was used for the comparison of the results. Theoretically, if the first and the second evaluations are exactly the same, the data should lie on a straight line $y = \beta_1 x + \beta_0$, where x represents the first measurement and y the repeated measurement, while β_0=0 and β_1=1. Comparison of two evaluations leads to the function of linear regression, when regression coefficients β_0 and β_1 are tested. Hypotheses H_0: β_0=0 a β_1=1 are tested against alternative hypotheses H_1: $\beta_0 \neq 0$ and $\beta_1 \neq 1$. The testing of the hypotheses was solved at the significance level α=0.05 and the statistical software STATISTICA 9 and QCExpert were used for all calculations.

In the following analysis and tables (Table 4 - 8) S means that estimations of regression coefficients are significant ($\beta_i \neq 0$) at the level of significance α=0.05 and N presents that estimations of regression coefficients are not significant (β_i=0) at the same level of significance.

4.1. Verification of repeatability of the total hand

To verify if the evaluators can evaluate the hand in the same way repeated evaluation by the same group of evaluators under the same conditions was used. The experiment was divided into two parts. Repeatability of the total hand was monitored as follows:

a) without visual stimuli – evaluated by group 1,
b) with visual stimuli – evaluated by groups 1 and 2.

4.1.1. Without visual stimuli

The results (Tab.4) show that regression coefficient β_0 is statistically insignificant, coefficient β_1 is statistically significant and its 95% confidence interval covers number 1. These results indicate that these two evaluations can be understood as identical. The correlation coefficient s_r is 0.77,

Tab.3 Basic characteristics of a sample rating median x_R.

	group 1				group 2		group 3	
	Without visual stimuli		with visual stimuli		with visual stimuli		without visual stimuli	with visual stimuli
	1st eval.	2nd eval.	1st eval.	2nd eval.	1st eval.	2nd eval.		
mean	5.7	5.7	5.8	6.0	6.3	6.0	5.9	4.9
minimum	1.9	2.3	2.9	3	3.7	3.4	3.5	2.6
maximum	9.1	9.2	9.1	8.8	10.1	9.2	9	7.9

Tab.4 Repeatability of total hand without visual stimuli

	group 1	
regression coefficient	b_0	b_1
estimation	1.3	0.77
standard deviation	0.73	0.12
conclusion - significance	*N*	*S*
probability	0.087	0.000
95 % conf. int. – lower limit	-0.2	0.52
upper limit	2.79	1.02
Spearman's rank corr. coef.	0.77	

Tab.5 Repeatability of total hand with visual stimuli

	group 1		group 2	
regression coefficient	b_0	b_1	b_0	b_1
estimation	1.55	0.77	1.39	0.73
standard deviation	0.69	0.11	0.68	0.10
conclusion - significance	S	S	S	S
Pprobability	0.033	0.000	0.050	0.000
95 % conf. int. – lower limit	0.14	0.53	0.002	0.52
upper limit	2.95	1.00	2.78	0.95
Spearman's rank corr. coef.	0.71		0.70	

which shows a high level of similarity in the fabrics hand evaluation (Fig.1).

4.1.2. With visual stimuli

Verification of the repeatability of the total hand with visual contact with fabrics by comparing the characteristics x_R was carried out by means of two panels of the groups of respondents (G1 and G2) when both groups evaluated fabrics hand twice. Based on the results (Tab.5), the groups came into similar conclusions. 95% confidence intervals of regression coefficients β_0 do not cover 0 and so $\beta_0 \neq 0$. Even though the estimation of regression coefficient β_1 cannot be understood equal to 1 from statistical point of view for group 2 (95% confidence interval does not cover 1) as in the case of group 1, on other hand, upper limits of confidence intervals for both groups are close to 1, therefore both evaluations lead to the similar conclusion. The second evaluations are different from the first ones as the correlation coefficients $\beta_0 \neq 0$. The results indicate that in the second case the judges from both the groups evaluated the total hand closer than in the first one. On the other hand, r_s in both the cases reach the value close to 0.70, which shows a positive agreement in evaluations - fabrics evaluated as fabrics with better (worse) hand in the first evaluations were also evaluated as fabrics with better (worse) hand in the course of the second one.

4.2. Verification of reproducibility of the total hand

Reproducibility was verified by means of three groups of judges while all the other conditions were the same. Verification was made at both with and without visual stimuli. Compared groups:

a) without visual stimuli – G1 and G3,
b) with visual stimuli – all three groups.

In the case when the groups evaluated THV with or without stimuli twice (G1 and G2) the first and the second evaluations were compared only, because in the cases of the second evaluation the panellists were more experienced than at the beginning of testing. For the same reason the first

evaluations of G1 were compared with the results of G3.

4.2.1. Without visual stimuli

The regression coefficient R=0.72 shows high accord in evaluations between G1 and G3 (Tab.6). This can be caused by the fact that only 10 fabrics were compared and there exists better distinctiveness in hand among fabrics. It is evident from Fig.2, that both groups evaluated the fabrics from both outer parts of the ordinal scale in accordance. However, results $\beta_0 \neq 0$ and $\beta_1 \neq 1$ indicate that assessments of G1 and G3 are different. Panellists from G3 do not use extreme categories so frequently and so the range of results of x_R is more narrow (from 3.5 to 9) than at G1 where the interval is 1.9 – 9.1.

4.2.2. With visual stimuli

Assessment of total hand with visual stimuli was carried out by all the three panels of respondents. The groups 1 and 2 did this experiment twice. This type of evaluations is closest to the real situation during which a consumer evaluates the hand along with visual stimuli. The results are presented in Tab.7.

The results do not provide clear conclusions. According to the values of regression coefficients there exists concordance in the evaluations of the total hand between groups 1-3 and 2-3. From the statistical point of view this concordance is given by the high standard deviation of β_0 which led to covering value 0 by its confidence interval. The results from Tab.3 show that G3 evaluated the total hand worse than the other two groups, so the visual aspect apparently affected their assessment.

The value of r_s (0.64) between G1 and G3 indicates less agreement than between G2 and G3. The different results can be explained in the following way. The fabrics with total hand belonging to the best were classified by the groups more unambiguously. However, G1 also evaluated the fabrics with bad total hand more unambiguously than G3 (see Fig.3) or G2. The lower value of r_s (<0.7) among G1 and other two groups also means that all the groups could be affected by the visual aspect of the fabrics during their evaluations.

Although the second evaluations of G1 and G2 could be expected to lead to more correlating results due to evaluators´ wider experience, the analyses do not confirm this assumption. Spearman's rank correlation coefficient decreased from 0.67 to 0.58. That was apparently caused by similar quality of the hand in the middle part of the scale, so the judges were

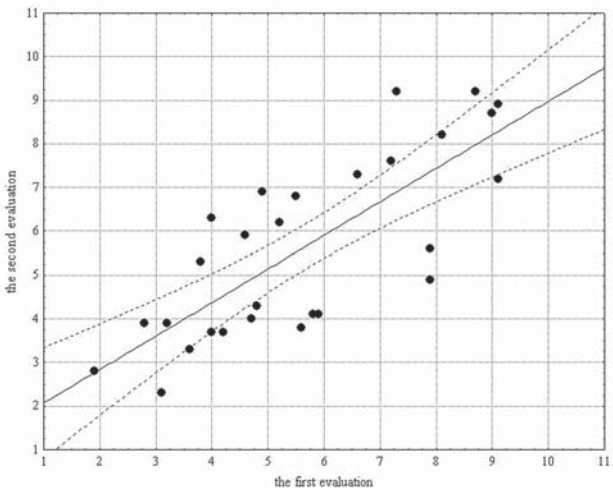

Fig.1 Repeatability – comparison of the first and the second evaluations of x_R without visual stimuli – group G1.

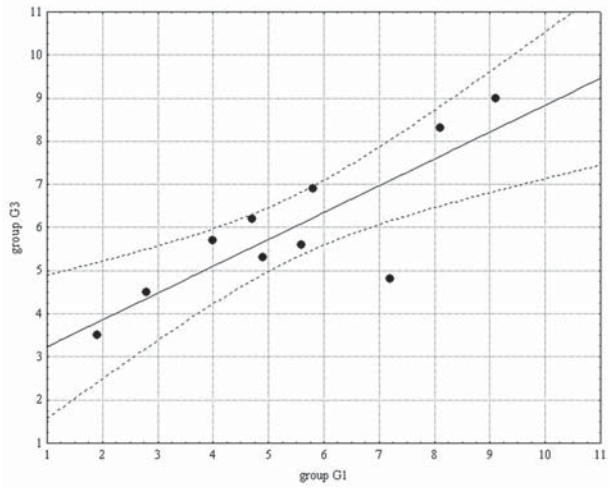

Fig.2 Reproducibility - comparison of the first evaluations of x_R without visual stimuli – between group G1 and group G3.

Tab.6 Reproducibility of total hand without visual stimuli

	between groups 1 and 3	
regression coefficient	b_0	b_1
estimation	2.52	0.63
standard deviation	0.83	0.14
conclusion - significance	S	S
probability	0.017	0.002
95 % conf. int. – lower limit	0.59	0.30
upper limit	4.44	0.96
Spearman's rank corr. coef.	0.72	

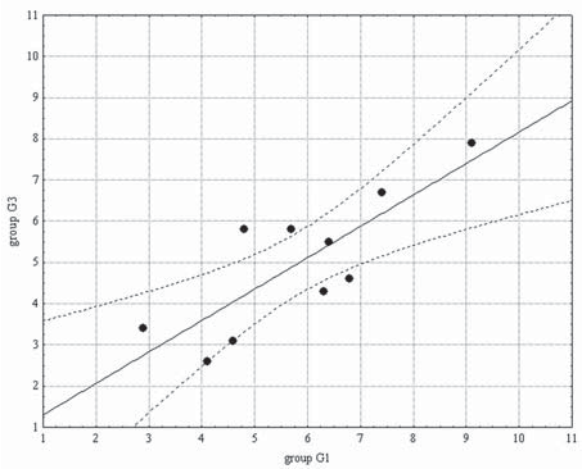

Fig.3 Reproducibility - comparison of the first evaluations of x_R with visual stimuli – between group G1 and group G3.

able to differ more easily in their classification to the categories.

As the estimation of β_1 is not equal to 1 and β_0 is positive, the results may lead to the conclusion that at the repeated evaluation, the judges from the second group evaluated the hand in average better and closer to each other than G1.

4.3. Influence of visual stimuli on the subjective hand evaluation

Groups 1 and 3 took part in the examination of the influence of a visual stimulus on the subjective hand evaluation. Both groups evaluated the hand with and without visual contact. As G1 carried out the evaluation repeatedly, for the comparison with G3 the first evaluations of G1 were taken for comparison. The results (Tab.8) show a high accord in the evaluation with and without visual contact at G1. Although the result at G3 is similar to that of G1, the standard deviation of regression coefficient β_0 is high, and therefore confidence interval covers value 0.

In both cases r_s is high (>0.7), which indicates that the evaluators are able to restrain themselves from visual stimuli during hand evaluation. If the evaluators are instructed, they are able to restrain themselves from the visual aspect of the textile during evaluation. However, despite the accord in evaluation at G3 similar to that in G1, it is necessary to state that G3 on the average evaluated the hand with visual contact worse than G1 – the difference in the total average median of ordinal scale is 0.8 (Tab.3). As both the groups, on the average, evaluated the hand similarly, G3 did not manage to restrain themselves completely from the influence of the

Tab.7 Reproducibility of total hand with visual stimuli

	between groups 1 and 2 – the first evaluation		between groups 1 and 2 – the second evaluation		between groups 1 and 3		between groups 2 and 3	
regression coefficient	b_0	b_1	b_0	b_1	b_0	b_1	b_0	b_1
estimation	1.97	0.75	3.34	0.48	0.55	0.71	0.31	0.74
standard deviation	0.83	0.14	0.74	0.12	1.74	0.28	1.46	0.23
conclusion – significance	S	S	S	S	N	S	N	S
probability	0.025	0.000	0.000	0.001	0.758	0.034	0.837	0.013
95 % conf. int. – lower limit	0.26	0.47	1.83	0.23	-3.46	0.064	-3.06	0.21
upper limit	3.67	1.04	4.85	0.73	4.56	1.35	3.68	1.28
Spearman's rank corr. coef.	0.67		0.58		0.64		0.71	

Tab.8 Influence of Visual stimuli on evaluation of total hand

	group 1		group 3	
regression coefficient	b_0	b_1	b_0	b_1
estimation	2.11	0.64	0.40	0.76
standard deviation	0.62	0.10	1.10	0.18
conclusion - significance	S	S	N	S
probability	0.002	0.000	0.728	0.003
95 % conf. int. – lower limit	0.843	0.43	-2.14	0.34
upper limit	3.40	0.85	2.94	1.17
Spearman's rank corr. coef.	0.74		0.78	

visual aspect on their hand evaluation, which showed in the relatively big difference of the total mean of median of ordinal scale 5.9 without visual stimuli against 4.9 with visual stimuli (Tab.3), but the trend in the evaluation was kept. Apparently, an important role was played by the change of fashion in patterns and colours during more than 8 years that had passed between the evaluations.

5. Conclusion

During subjective hand evaluation the visual stimuli of the evaluated samples of fabrics can affect the final decision. For verification of the influence of visual examination three groups of respondents were chosen. The evaluation was carried out during approximately one decade. The analyses showed a certain accord among the evaluations of total hand. Most of the values of Spearman's rank correlation coefficients reached values higher than 0.7 which indicates the same trend in the evaluations. On the other hand, although some findings on the basis of the linear regression analysis showed differences in the assessment, all evaluations had the same tendency. Most of the fabrics chosen by experts as fabrics with very good hand were also classified in the same way very clearly by all groups of respondents. The similar tendency but not so apparent was detected at fabrics with bad hand. This can be explained by the fact that manufacturers do not launch products with downright bad hand but they aim is to present and sell fabrics with pleasant hand. The analyses of the evaluations carried out by the same group under the same conditions indicate a high accord between the first and the second evaluations in all the groups (Spearman's rank correlation coefficients ≥ 0.70) which indicates a possibility of reaching repeatability. The results concerning the reproducibility do not lead to such a clear conclusion. Part of analyses show that there are differences in the evaluations (Spearman's rank correlation coefficients <0.65), the other part shows similar evaluations. (Spearman's rank correlation coefficients >0.7).

It can be said that if evaluators are instructed properly how to evaluate and understand the definitions of properties and the ways of their evaluation, both repeatability and reproducibility of the hand evaluation can be ensured to a certain level, as well as constancy in evaluation within a longer time period. This conclusion also applies to the elimination of the visual contact influence – appearance of fabrics (Spearman's rank correlation coefficients were higher than 0.78). Then creation of a model for objective evaluation has sense because the model can be used in a long time period.

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